



JURONG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE
NAME

CLASS

CHEMISTRY

Paper 2 Structured

8872/02

28 August 2009

2 hours

Candidates answer Section A on the Question Paper

Additional Materials:

Answer Paper
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

A Data Booklet is provided. Do not write anything on the *Data Booklet*.

Section A

Answer **all** questions.

Section B

Answer **two** questions on separate answer paper.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
Section A	
B4	
B5	
B6	
Total	

This document consists of **11** printed pages and **1** blank page.

[Turn over

Section A

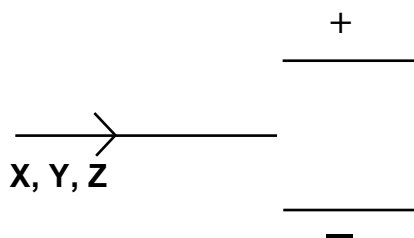
Answer **all** questions in this section in the spaces provided.

1. (a) Complete the table below.

Particle	Electric charge	Mass number	Number of		
			Protons	Electrons	Neutrons
X	0		16		16
Y	1-	81		36	
Z		70	31	28	

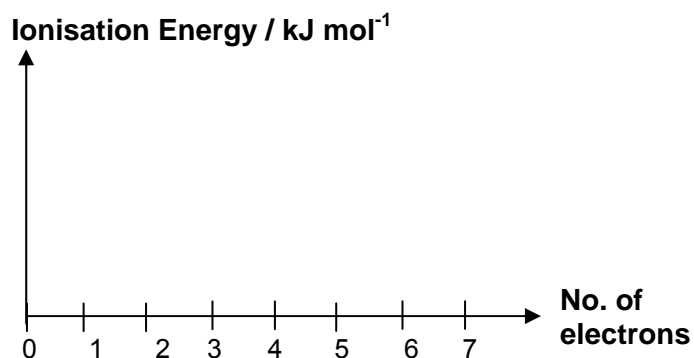
[2]

- (b) Beams consisting of particles **X**, **Y** and **Z** are subjected to an electric field as shown in the diagram below. Sketch, and label, on the diagram below to show how beams of each of the three particles are affected by the electric field.



[3]

- (c) Using the grid provided below, sketch a graph of the seven successive ionisation energies for element **X**.



[2]

[Total:7]

2. (a) On heating, sodium nitrate, (NaNO_3) decomposes giving the sodium nitrite, (NaNO_2) and oxygen while magnesium nitrate, ($\text{Mg}(\text{NO}_3)_2$), decomposes giving magnesium oxide, nitrogen dioxide and oxygen.
- (i) Write balanced equations for the decomposition of sodium nitrate and magnesium nitrate respectively.

[2]

- (b) (i) 5.35 g of a mixture of sodium nitrate, (NaNO_3) and magnesium nitrate, ($\text{Mg}(\text{NO}_3)_2$), was heated in a fume cupboard until no more gases were evolved. The sodium nitrite, (NaNO_2), formed was dissolved in water to form a 250 cm^3 solution of nitrite ions, NO_2^- . The nitrite ions in the solution reacted with 40.00 cm^3 of acidified potassium manganate(VII) solution.

The nitrite ion half equation is given by:



Write a balanced equation for the reaction between nitrite ions and manganate(VII) ions.

[2]

- (ii) Given that the concentration of the acidified potassium manganate(VII) solution was $0.200 \text{ mol dm}^{-3}$, calculate the number of moles of potassium manganate(VII) that reacted.

[1]

- (iii) Calculate the number of moles of sodium nitrite, (NaNO_2), in 250 cm^3 of the solution.

[1]

2. (b) (iv) Calculate the number of moles of sodium nitrate, (NaNO_3), in 5.35 g of the mixture.

[1]

- (iv) Hence calculate the respective mass of sodium nitrate, (NaNO_3) and magnesium nitrate, ($\text{Mg}(\text{NO}_3)_2$), in the mixture.

[2]

[Total: 9]

3. Propane, C_3H_8 , is isolated from bottled gas used for cooking and heating.

- (a) Write an equation for the complete combustion of propane.

[1]

- (b) The density of propane is 1.83 g dm^{-3} .

- (i) Calculate the number of moles of propane present in 50 cm^3 .

3. (b) (ii) Calculate the volume of oxygen (measured at room temperature and pressure) that would be required to completely burn 50 cm³ of propane.

[4]

- (c) (i) Write an equation which represents the standard enthalpy change of formation of gaseous propane.

- (ii) Use the following standard enthalpy changes of combustion, ΔH_c° , to calculate the standard enthalpy change of formation of propane.

<i>substance</i>	$\Delta H_c^\circ / \text{kJ mol}^{-1}$
carbon	–393
hydrogen	–286
propane	–2219

[3]

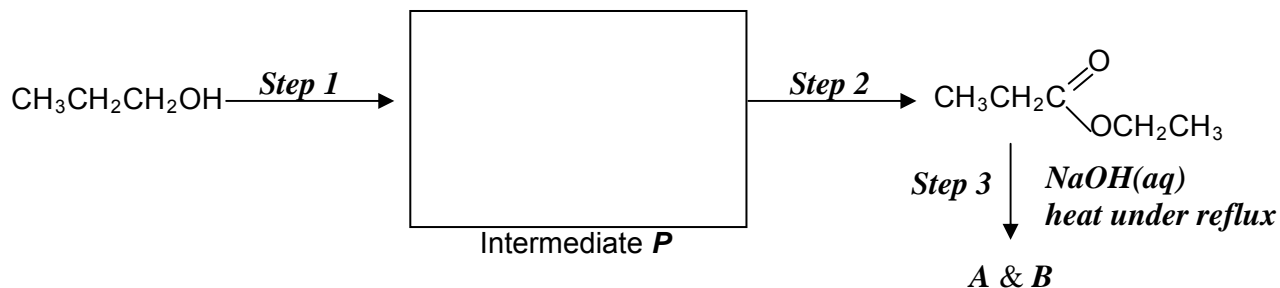
- (d) Given that the activation energy for the standard enthalpy change of formation of propane is 100 kJ mol^{–1}, draw a labelled energy profile diagram for the reaction.

[2]

[Total: 10]

4. (a) For the following two conversions, state clearly the reagents and conditions required in each step. Draw the structure of intermediate **P** formed in the box provided.

(i)



Reagents and conditions:

Step 1: _____

Step 2: _____

- (ii) Draw the structures of products **A** and **B**. State the type of reaction for **Step 3**.



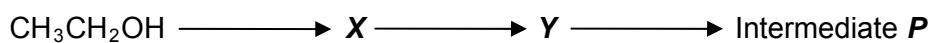
A



B

Type of reaction: _____

- (iii) Intermediate **P** can be synthesized from ethanol in 3 steps as shown below:



Draw structures of **X** and **Y** in the boxes below.



X



Y

[8]

4. (b) Draw the structures of the organic products formed when butan-2-ol reacts with the following reagents:

(i) Hot acidified potassium dichromate(VI).

(ii) Alkaline aqueous iodine

(iii) Na

[3]

- (c) Butan-2-ol reacts with hot concentrated sulphuric acid to form two isomers **M** and **N**. **M** exhibits stereoisomerism while **N** does not.

(i) Draw the structure of **N**.

(ii) With the aid of diagrams, show how **M** exhibits stereoisomerism.

[3]

[Total: 14]

Section B

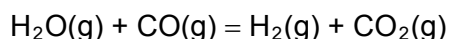
Answer **two** of the three questions in this section on separate paper.

1. This question is about ethanoic acid and methanol.

(a) Vinegar is a dilute solution of ethanoic acid, CH_3COOH .

- (i) Write an expression for the acid dissociation constant, K_a , for ethanoic acid.
- (ii) When 0.15 g of pure ethanoic acid is dissolved in water and made up to 100 cm^3 , the resulting pH is 3.18. Use this information to calculate the value of K_a for ethanoic acid. Include a unit in your answer.
- (iii) State an assumption made in your calculation.
- (iv) Calculate the volume of 0.050 mol dm^{-3} aqueous barium hydroxide needed to neutralise the 100 cm^3 of ethanoic acid solution in (ii).
- (v) Suggest a suitable indicator for the titration and state the colour change at the end-point for the indicator you have suggested. [10]

(b) One of the steps involved in the synthesis of methanol involves the water-gas shift reaction. In this reaction, a mixture of steam and carbon monoxide will form an equilibrium mixture as shown by the equation.



The reaction is an example of a *dynamic equilibrium*.

- (i) Explain the meaning of the term *dynamic equilibrium*.
- (ii) 1.0 mol of steam and 1.0 mol of carbon monoxide are allowed to react at 230°C . At equilibrium, there was 0.67 mol of hydrogen gas present. Calculate the equilibrium constant, K_c , at this temperature and state its units.
- (iii) State and explain what would happen to the equilibrium position if the initial concentration of steam was increased.
- (iv) Explain, with the aid of an appropriate diagram, the effect, if any, on the rate of attainment of the equilibrium when the temperature of the system is increased. [10]

[Total: 20]

2. This question is about alcohols.

(a) Alcohols can be classified as primary, secondary or tertiary. Describe how you would classify alcohols in these groups by heating them with acidified potassium dichromate(VI) and, where necessary, carrying out a further test on the product. You should include any reagents and give the expected observations. **Equations are not required.**

[4]

(b) The ester formed between propan-1-ol and ethanoic acid contributes to the flavour of ripe pears.

(i) Draw the **displayed** formula of the ester.

(ii) State whether ethanoic acid or propan-1-ol is the stronger acid. Explain your answer.

[4]

(c) Propan-1-ol can be converted to 1-bromopropane in one step.

(i) Suggest the reagents and conditions necessary for this conversion.

(ii) Describe a chemical test that can distinguish 1-bromopropane from bromobenzene.

[3]

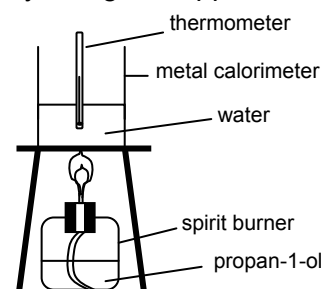
(d) (i) Define the term *standard enthalpy change of combustion*.

(ii) Use the following standard enthalpies of formation to calculate the standard enthalpy change of combustion of propan-1-ol.

Compound	CO ₂ (g)	CH ₃ CH ₂ CH ₂ OH(l)	H ₂ O(l)
$\Delta H_f^\circ / \text{kJ mol}^{-1}$	-394	-304	-286

(iii) Experimentally, a value for the standard enthalpy change of combustion of propan-1-ol can be determined in the laboratory using the apparatus shown below.

The following results were obtained.
mass of water in the calorimeter = 100g
initial temperature of water = 25.0°C
final temperature of water = 32.5°C
original mass of burner + propan-1-ol = 53.35 g
final mass of burner + propan-1-ol = 53.25 g
specific heat capacity of water = 4.18 J g⁻¹ K⁻¹



Use these results to calculate the experimental enthalpy change of combustion for propan-1-ol.

(iv) Give one reason why you would expect your answer to (iii) to differ from that in (ii).

[7]

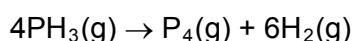
(e) Explain why propan-1-ol is miscible with water. Include a diagram in your answer.

[2]

[Total: 20]

3. This question is about phosphorus and its compounds.

- (a) (i) State the full electronic configuration of phosphorus.
- (ii) Suggest how the first ionisation energy of phosphorus would compare to that of sulphur and explain your reasoning. [3]
- (b) One of the products from the reaction of phosphorus and sulphur is phosphorus sulphide, P_4S_3 , which is used in small amounts in the tip of a match. On striking a match, this compound burns to give phosphorus(V) oxide, P_4O_{10} and sulphur dioxide, SO_2 .
- (i) Construct a balanced equation for the reaction of P_4S_3 to form the respective oxides.
- (ii) Both oxides formed in (i) dissolve in water. Construct an equation for the reaction of each oxide with water. [3]
- (c) Phosphorus reacts with limited amount of chlorine to give PCl_3 and excess chlorine to form phosphorus pentachloride, PCl_5 .
- (i) Draw and name the shapes of PCl_3 and PCl_5 .
- (ii) Explain why PCl_5 sublimes at 160°C while PCl_3 boils at 76.1°C .
- (iii) Describe, with an equation, the reaction of PCl_5 , with water. What would be the effect of adding universal indicator to the product? [7]
- (d) Phosphorus compounds are also used in the pharmaceutical industries. For example, solutions containing hydrogen phosphates are used as buffers found in the hydrophilic gel used in skin patches. Write equations to show how the solution containing $H_2PO_4^- / HPO_4^{2-}$ can act as a buffer when H^+ and OH^- ions are added respectively to the solution. [2]
- (e) Phosphine, PH_3 , is a widely used fumigant. The thermal decomposition of phosphine into phosphorus and hydrogen is a *first-order reaction*.

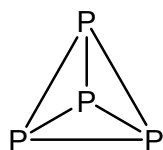


- (i) Explain the term in *italics*.
- (ii) Sketch a graph of rate against concentration for the decomposition reaction.

The half-life of the reaction is 35.0 seconds at 680°C . Calculate

- (iii) the rate constant for the reaction.
- (iv) the time taken for 87.5% of the phosphine to decompose.

3. (e) (v) Given that phosphorus has the structure shown below and the following bond energy values, calculate the enthalpy change for the decomposition reaction.



bond	bond energy / kJ mol ⁻¹
P-H	326
P-P	209
H-H	435

[5]

[Total: 20]